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# Internet-based aftercare for women with bulimia nervosa following inpatient treatment: The role of adherence☆

Ina Beintner*, Corinna Jacobi

*Chair of Clinical Psychology, E-Mental-Health, Technische Universität Dresden, 01062 Dresden, Germany*

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ABSTRACT

Facing poor long-term outcome and high relapse rates in the treatment of bulimia nervosa, we developed an Internet-based aftercare program for women with severe and chronic bulimia nervosa following inpatient treatment based on previous experiences with self-directed targeted prevention and early intervention programs delivered online. The aim of the present study was to examine adherence to the program in detail, to explore potential variables that predict adherence and to analyze whether adherence affects outcomes. We analyzed data from 126 women in the intervention group of a randomized controlled trial. 107 women (85%) logged on to the program platform at least once. These women opened on average 42.8% (SD = 31.9%) of all assigned program pages. Adherence declined during the course of the intervention. Adherence was not associated with the number of outpatient treatment sessions received during the intervention period. Adherence was not related to overall illness severity or duration at baseline. However, excessive exercise at hospital discharge (which may be a sign of insufficient motivation to change eating disorder related behaviors) seems to play some small role in adherence. Adherence did not affect intervention outcomes. Based on our findings, we would like to advocate further research on online aftercare interventions for women with severe and chronic bulimia nervosa.

## 1. Introduction

Relapse rates in bulimia nervosa are high (34–70%), even after successful treatment (Olmsted et al., 1994, 2005; Richard, 2005). Research findings suggest that women with bulimia nervosa who have achieved symptom improvement or remission seem reluctant to seek further treatment if they relapse (Mitchell et al., 2004). Technology-enhanced approaches have been utilized in aftercare interventions following inpatient or outpatient treatment for a variety of mental health problems (e.g., Barnes et al., 2007; Ebert et al., 2013; Valiollah Golkaramnay et al., 2007; Golkaramnay et al., 2003; Moessner et al., 2014).

Encouraged by the high acceptance (Beintner et al., 2014b; Manwaring et al., 2008) and demonstrated efficacy of Internet-based prevention programs for eating disorders in clinical trials (Beintner et al., 2012; Stice et al., 2007), we developed a structured, Internet-based aftercare program ("IN@") for women with bulimia nervosa following inpatient treatment (Beintner and Jacobi, 2011; Jacobi et al., 2017). The intervention was designed to help patients maintain the progress they had achieved during inpatient treatment and prevent or reduce relapse after discharge from the hospital.

Overall, while yielding a small effect on the reduction of self-induced vomiting at post-intervention, the impact of the intervention on abstinence rates was not as favorable as expected and participation was low (Jacobi et al., 2017). In order to understand these findings, it is important to investigate how the women who had access to the intervention made use of it, which patient characteristics predicted adherence, and whether adherence affected intervention outcomes.

In manualized self-help interventions for women with bulimia nervosa, almost half of the participants quit before completing half of the assigned intervention sessions or modules (Beintner et al., 2014a, 2014b). In studies evaluating Internet-based self-help interventions for women with bulimia nervosa, there is large variation in participant adherence and how adherence is reported. In one study only 31% of participants had "reached the last module" of the Internet-based intervention at the time of post-intervention assessment (Carrard et al., 2011b). Yet, in another study 74% were reported to have "completed the full treatment" (Ruwaard et al., 2013). In a third study, 57% of participants engaged in at least four out of eight online sessions (Sanchez-Ortiz et al., 2011a, 2011b), while in a fourth study (Wagner

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* Corresponding author.
*E-mail address:* Ina.beintner@tu-dresden.de (I. Beintner).

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et al., 2013), 58% of the participants remained in the intervention for at least 2 months and completed three or more modules. Authors of a fifth study (Leung et al., 2013) report that 34% used the program for at least one months, while in a sixth study, 60% of patients with bulimia nervosa completed the web-based intervention (ter Huurne et al., 2015). It must, however, be noted that, for none of these studies, authors gave information on the specific criteria that had to be fulfilled to consider a module reached or the treatment completed.

The efficacy of several technology-enhanced *aftercare interventions* for patients with eating disorders following inpatient treatment has been investigated in two previous randomized controlled trials. The focus of aftercare interventions usually is to maintain treatment gains and prevent relapses. In an Internet-based relapse prevention intervention for women with anorexia nervosa (Fichter et al., 2012), 40% of patients had utilized all nine modules "according to the protocol" (p. 186; no further information was given on when a module was considered utilized), while 24% completed less than four modules. Group chat sessions were used by 60% of the participants and 88% contacted their coach at least once via email. In a relapse prevention program based on text messaging targeting women with bulimia nervosa (Bauer et al., 2011), 95% of patients actively "used" the program–i.e. they sent at least one text message–and 61% used the program over the course of 16 weeks. Again, the authors did not specify how many messages had to be written for the program to be considered used. Both interventions had been designed as augmentations to outpatient aftercare and in both studies, a substantial proportion of patients had received additional treatment, namely 54% (Bauer et al., 2011) and 93% (Fichter et al., 2012).

In a study on Internet-based maintenance treatment for eating disorders following inpatient or outpatient treatment that included weekly monitoring and feedback, psychoeducational content, and group chat sessions (Gulec et al., 2011; Gulec et al., 2014), participants in the intervention group attended on average six group chat sessions and filled in seven monitoring assessments during the 4-month intervention period. Only one in four participants booked at least one individual chat session and one in three posted at least one entry in the forum. The information material was used by one in three participants.

However, information on program adherence for these three studies is insufficient to facilitate conclusions about their true public health impact. More research is needed to assess the reach and utilization of technology-enhanced aftercare interventions and usage metrics need to be reported more consistently to explicitly facilitate understanding of intervention utilization.

The first aim of the present study was to examine adherence in an Internet-based aftercare program for women with bulimia nervosa following inpatient treatment in detail. A second aim was to examine potential moderator variables that predict adherence and to analyze whether adherence in general or the usage of specific intervention components affects outcomes. Findings have the potential to increase knowledge about the impact of the intervention on health care utilization and also help to guide the design of future interventions.

## 2. Method

### 2.1. Design, sample and procedure

The current study examines data from 126 women randomly allocated to the intervention group in a randomized controlled trial (ISRCTN08870215), in which a 9-month manualized Internet-based aftercare program for women with bulimia nervosa following inpatient treatment was evaluated in comparison to a treatment-as-usual condition. We recruited participants from 13 psychosomatic hospitals in Germany. Assessments took place at hospital admission and discharge as well as post intervention. The trial was approved by the human subjects committees of Technische Universität Dresden and medical associations of the federal states in which the hospitals were located.

The women in the intervention group were, on average, 25.6 years old (SD = 7.2) and had suffered from bulimia nervosa for 6.6 years (SD = 5.6). At hospital admission, they reported an average of 13.7 binge eating episodes (SD = 11.9) and 22.6 episodes of compensatory behaviors (SD = 20.3) per week. One in three of the women had a history of anorexia nervosa and 87% had received psychotherapeutic or psychiatric treatment before being admitted to hospital. Most women (83%, $n$ = 105) also received psychotherapeutic face-to-face outpatient treatment (M = 27 sessions; SD = 24) while having access to the Internet-based aftercare intervention.

### 2.2. Intervention

The Internet-based, cognitive-behavioral intervention IN@ has been described in detail elsewhere (Beintner and Jacobi, 2011; Jacobi et al., 2017). It comprised 11 consecutive sessions over 9 months and includes reading assignments as well as email feedback (as required by patients) and monthly real-time one-to-one online chats with a clinical psychologist specialized in eating disorder treatment. The program covered a number of topics relevant for the treatment of eating disorders, such as eating behavior, body image, self-esteem, perfectionism, emotion regulation, and interpersonal effectiveness. Personal goal setting, a personal diary and self-monitoring diaries allowed patients to target core eating disorder symptoms and monitor and challenge eating disorder related automatic thoughts and attitudes.

### 2.3. Baseline measures

Prior to randomization, all patients were interviewed both at hospital admission and discharge. At admission to the hospital, eating disorder symptomatology was assessed by the Structured Inventory for Anorexic and Bulimic Syndromes according to DSM-IV and ICD-10 (SIAB-EX; Fichter and Quadflieg, 2001) and comorbid disorders were diagnosed with the structured clinical interview for DSM-IV Axis I mental disorders SCID (Wittchen et al., 1997) interview. A detailed description of the study design, procedure, measures and assessment points of the trial is provided elsewhere (Beintner and Jacobi, 2011; Jacobi et al., 2017).

The following variables were included in the analysis as potential moderators of adherence: Age, marital status, and level of education at randomization; history of anorexia nervosa; duration of bulimia nervosa and age of bulimia nervosa onset, utilization of in- and outpatient treatment prior to hospital admission; comorbid anxiety, affective, substance related and somatoform disorders; history of anxiety, affective and substance related disorders; BMI at hospital admission; binge eating frequency, vomiting frequency, number of days with excessive exercise; frequency of all compensatory behaviors, SIAB-EX subscale scores at hospital admission and discharge; abstinence from binge eating and compensatory behaviors at hospital discharge; duration of inpatient treatment prior to the aftercare intervention.

### 2.4. Measures of adherence

A participant was considered a *study dropout* if she did not provide post-intervention data on the primary outcome (core bulimic symptoms). *Overall adherence* was defined as the proportion of all assignments completed by each participant. Assignments included reading the psychoeducational content and completing in-program surveys with one or multiple free text boxes and a weekly symptom diary which assessed core ED symptoms (binge eating, compensatory behaviors) as well as a goal setting task at the end of each session. Adherence was recorded automatically by the Internet-platform through log files. Reading assignments were considered completed when the patient had opened the respective pages. Free Text surveys were considered completed when an entry had been made in at least one of the fields. The symptom diary was also considered completed when at least one field

was filled in (this approach was chosen because a considerable number of patients left fields addressing symptoms they did not experience blank). The personal goal setting task included in each session was considered completed if a patient had set at least one goal. The use of the symptom diary was operationalized as the number of weeks the symptom diary had been filled out. The use of the online chats was operationalized as the number of one-to-one online chats a patient engaged in.

### 2.5. Outcome measures

In the current study, we included the following core eating disorder related outcomes: 1) abstinence from binge eating and purging during the past two months prior to post-intervention and follow-up, 2) frequency of binge eating episodes and of episodes of compensatory behaviors (vomiting, excessive exercise, fasting, abuse of laxatives, diuretics or other medications that affect appetite, digestion or metabolism) per week in the 3 months prior to post-intervention (i.e., 9 months after hospital discharge) and at follow-up (i.e., 18 months after hospital discharge).

### 2.6. Analyses

#### 2.6.1. Adherence

We calculated means and standard deviations of the above-defined adherence measures, excluding women who had never logged on to the platform. Accordingly, we calculated the average utilization of several features of the program (personal goal setting task, symptom diaries, chats), excluding women who had not used the respective program feature. Moreover, we analyzed the correlation between adherence to the Internet-based intervention and the number of additional outpatient treatment sessions in which patients had participated during the intervention period.

#### 2.6.2. Predictors of adherence

Because IN@ represents a novel aftercare approach for patients with bulimia nervosa and because findings on patient characteristics as predictors of adherence to ED treatment are scarce, we decided to employ an empirical approach for the identification of moderators of several adherence measures (study dropout, overall adherence, use of personal goal setting task, use of symptom diary, use of one-to-one chats) as proposed by the MacArthur Foundation (Kraemer et al., 2001; Kraemer et al., 2002). In a first step, correlations between overall adherence and all available baseline variables were determined and baseline variables that did not significantly (i.e., $p \geq .05$) correlate with overall adherence were excluded from further analyses. In a second step, correlations between those baseline variables that correlated significantly with overall participation were calculated and proxies were excluded from further steps of the analyses. A variable was considered a proxy for another variable if all of the following conditions were met: 1) both variables are significantly correlated with the outcome, 2) both variables are significantly correlated with each other, 3) both variables are measured at the same time and 4) both variables reflect interrelated behaviors (Kraemer et al., 2005; Kraemer et al., 2001). In a third step, adherence measures were regressed on each of the remaining baseline variables (see Table 1). Finally, when an adherence measure was predicted by more than one variable, the predictors were entered in a stepwise forward regression analyses to determine the final prediction model.

### 2.7. Associations between adherence measures and intervention outcomes

Each outcome measure as described above (abstinence from binge eating and purging, frequency of binge eating episodes and of compensatory behaviors at post-intervention and follow-up) was regressed on each of the adherence measures (overall adherence, use of personal goal setting task, use of symptom diary, use of one-to-one chats) in a logistic (dichotomous outcomes) or linear (continuous outcomes) model.

For all regression analyses, we performed completer analyses for each outcome, including all women for whom complete post-assessment data was available.

## 3. Results

### 3.1. Adherence

The majority of the 126 women in the intervention group (85%, $n = 107$) logged on to the program platform at least once, while 15% of the sample ($n = 19$) never logged on.

The women who logged on at least once opened on average 42.8% (SD = 31.9%) of all assigned program pages. Adherence was higher for pages that only included reading assignments (47.7%, SD = 32.7%) than for pages that required some kind of input, e.g. surveys or diaries (34.3%; SD = 32.5%). Women who logged on at least once accessed on average five of the eleven sessions (Md = 6). Adherence declined during the course of the intervention, with 85% of the sample ($n = 107$) logging on to session one, 46% of the sample ($n = 58$) logging on to session six and only 24% of the sample ($n = 30$) logging on to session 11 (see Fig. 1). While 20 women logged on to the program only once and should be deemed minimal users, 36 opened 9–11 sessions and can be considered loyal users; 34 women opened 2–5 sessions, and the remaining 17 women opened 6–8 sessions and can be deemed partial users. None of the adherence measures was associated with the number of outpatient treatment sessions received during the intervention period.

Eighty women (63% of the sample) used the personal goal-setting task of the program; they set goals on average 4.6 out of 10 times (Median = 5, SD = 3.1). Sixty-eight women (54% of the sample) used the weekly symptom diary; they filled in for on average 14 out of 39 weeks (Median = 9.5, SD = 12.9). Forty-seven women (37% of the sample) engaged in personal chats with their moderator with an average of 2.7 chats (Median = 2, SD = 2.3).

### 3.2. Predictors of adherence

Of the potential predictors of adherence at baseline, only two variables were correlated with *more than one* of the analyzed adherence measures: Excessive exercise in the two weeks prior to hospital discharge and level of education. The number of days with excessive exercise reported by the participants at hospital discharge significantly predicted three of the analyzed adherence measures: The more days with excessive exercise women reported at hospital discharge, the less they used the program, set themselves personal goals or filled out their symptom diaries.

Several moderators significantly predicted only *one* of the adherence measures: Women with a history of a substance-related disorder were more likely to drop out of the study. The number of binge eating episodes per week reported for the three months prior to hospital admission, SIAB-EX Bulimic symptoms subscale scores at hospital admission, and SKID lifetime anxiety disorders predicted the use of one-to-one chats. Women with a history of an anxiety disorder were more likely to engage in chats than women without a history of an anxiety disorder. The use of the symptom diary was predicted only by excessive exercise at hospital discharge, however, the explained variance was small. Women who reported more binge eating episodes prior to hospital admission or had higher scores on the SIAB Bulimic symptoms subscale were less likely to engage in chats (see Table 1).

For the three measures of adherence that were predicted by more than one moderator (overall adherence, use of personal goal feature, use of one-to-one chats), multiple linear regression analyses were performed to determine the final predictive model for each outcome (see

**Table 1**
Results of regression analyses for potential moderators of adherence measures.

| Measure | | | | | | |
|---|---|---|---|---|---|---|
| Moderator (significant correlation with participation measure) | *N* | Study dropout | Overall adherence | Use of personal goals setting task | Use of symptom diary | Use of one-to-one-chats |
| Marital status | 126 | n.s. | n.s. | n.s. | n.s. | n.s. |
| Level of education | 126 | n.s. | n.s. | n.s. | n.s. | $b_{Hauptschule} = 2.041^{*}$ $R^2 = 0.03$ $b_{Univ.Degree} = 1.576^{*}$ $R^2 = 0.03$ |
| Binge eating episodes at hospital admission | 126 | n.s. | n.s. | n.s. | n.s. | $b = -,032^{*}$ $R^2 = 0.03$ |
| Days with excessive exercise at hospital discharge | 126 | n.s. | $b = -3.84^{*}$ $R^2 = 0.04$ | $b = -0.346^{*}$ $R^2 = 0.03$ | $b = -^{*}$ $R^2 = 0.04$ | n.s. |
| SIAB-EX bulimic symptoms subscale at hospital admission | 126 | n.s. | n.s. | n.s. | n.s. | $b = -0.814^{*}$ $R^2 = 0.04$ |
| Lifetime anxiety disorder | 121 | n.s. | n.s. | n.s. | n.s. | $b = 0.999^{*}$ $R^2 = 0.04$ |
| Lifetime substance-related disorder | 124 | $b = 0.217^{*}$ $R^2 = 0.03$ | n.s. | n.s. | n.s. | n.s. |

Note: Hauptschule is a secondary school in Germany which offers lower secondary education (level 2) according to the International Standard Classification of Education.
SIAB-EX: structured inventory for anorexic and bulimic syndromes according to DSM-IV and ICD-10 (Fichter and Quadflieg, 2001)
* $p < .05$.

Tables 2a through 2c). In these models, overall adherence and the use of the personal goal-setting task were both predicted solely by the number of days with excessive exercise at hospital discharge. However, in both models, the degree of explained variance was small ($R^2 = 0.041$ and 0.032). The use of one-to-one chats was predicted by the level of education and SIAB Bulimia subscale scores at hospital admission. This model explains 12.9% of the variance in the use of one-to-one chats.

### 3.3. Associations between adherence measures and intervention outcomes

None of the adherence measures (overall adherence, use of personal goal setting task, use of symptom diary, use of one-to-one chats) was correlated with any of the intervention outcome measures (abstinence from binge eating and purging, frequency of binge eating episodes and compensatory behaviors at post-intervention and at follow-up).

## 4. Discussion

The aim of this study was to analyze different measures of adherence in an Internet-based aftercare program for women with bulimia nervosa (BN) following inpatient treatment, to identify moderators of adherence and to determine how adherence affects main study outcomes.

**Table 2a**
Final predictive model (multiple linear regression) of overall adherence.

| | Regression coefficient | Standardized beta | *p* |
|---|---|---|---|
| (Constant) | 39.275 | | < .001 |
| Days with excessive exercise at hospital discharge | −3.838 | −0.220 | .013 |

Adjusted R2 = 0.041, *N* = 126.

**Table 2b**
Final predictive model (multiple linear regression) of use of personal goal feature.

| | Regression coefficient | Standardized beta | *p* |
|---|---|---|---|
| (Constant) | 3.179 | | < .001 |
| Days with excessive exercise at hospital discharge | −0.346 | −0.199 | .026 |

Adjusted $R^2 = 0.032$. *N* = 126.

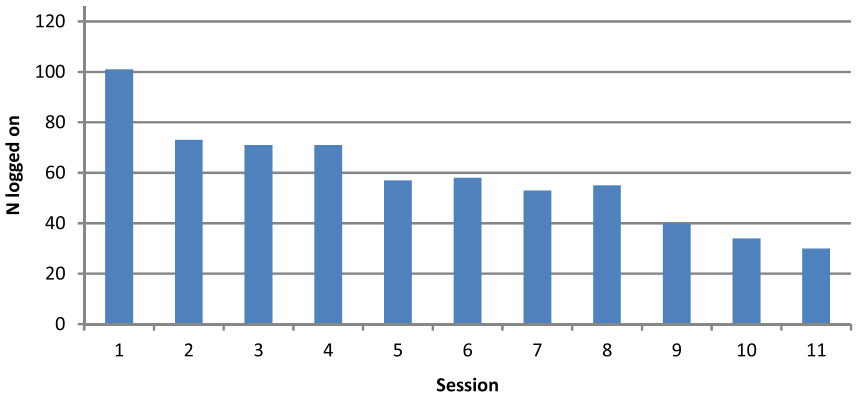


**Fig. 1.** Number of women logged on by session.

**Table 2c**
Final predictive model (multiple linear regression) of use of one-to-one chats.

| | Regression coefficient | Standardized beta | *p* |
|---|---|---|---|
| (Constant) | 3.512 | | .001 |
| Education: Hauptschule | 2.951 | 0.239 | .006 |
| Education: university degree | 1.641 | 0.212 | .014 |
| SIAB bulimic symptoms at hospital admission | −0.853 | −0.218 | .012 |

Adjusted $R^2 = 0.129$. $N = 121$.
Note: Hauptschule is a secondary school in Germany which offers lower secondary education (level 2) according to the International Standard Classification of Education.

### 4.1. Adherence

Adherence to the program was poorer than we had expected based on our experience from eating disorder prevention studies with participants accessing on average between 49% and 83% of the assigned intervention content (Beintner et al., 2014b) compared to just 42% in our aftercare study. While the majority of the women in the intervention group logged on to the program platform at least once, on average, the women opened less than half of all assigned program pages and accessed just over half of the assigned sessions. Adherence declined during the course of the intervention and was higher for reading assignments than for diaries or surveys. Almost one in three women either never logged on to the program or never returned after session one. At the same time, one in four women became loyal users of the program and completed nine or more sessions. Almost half of the women who used the program (i.e., who logged on at least once) participated in one-to-one live-chats with a clinical psychologist, but few women did so on a regular basis. More than half of the women who logged on at least once used the symptom diary and more than two out of three completed the personal goal setting task at least once. However, on average these features were used not nearly as many times as intended in the study protocol (Beintner and Jacobi, 2011). None of the adherence measures were associated with the number of outpatient treatment sessions received during the intervention period.

To date, few studies addressed adherence to *self-directed interventions for eating disorders* explicitly. Compared with an Internet-based aftercare intervention for women with anorexia nervosa (Fichter et al., 2012), a lower number of women in our BN aftercare study completed all modules. While in the latter study, four out of ten women with anorexia nervosa (AN) used all nine program sessions, only about three out of ten women used nine or more sessions in our study. Group chat sessions were joined by six out of ten women in the AN study, while one-to-one chats were joined by about four out of ten women in our study. While both aftercare programs were developed within the same research consortium and thus were quite comparable in design, different recruitment strategies had been used: We recruited women from a total of 13 psychosomatic hospitals throughout Germany, and our BN aftercare intervention was offered by a clinical psychology department of a university and guided by university staff. In the AN aftercare study, women also were recruited from several – though fewer – psychosomatic hospitals, but the aftercare intervention was offered by one of these hospitals for specialized ED treatment and guided by hospital staff. This may have increased the credibility of the intervention and loyalty to the Internet intervention, especially in the subsample of patients who were recruited from that specific hospital (Crutzen et al., 2011; Gummerus et al., 2004; Jung and Berthon, 2009).

In a German relapse prevention program for women with bulimia nervosa based on text messaging (Bauer et al., 2011; Bauer et al., 2012), authors reported that 95% of patients sent at least one text message, while, in our study, 85% logged on at least once. While in the text messaging trial about half of the patients in the intervention group received additional outpatient treatment, this was true for more than three quarters of the patients in our sample. This may have contributed to a slightly larger rate of patients not taking up the intervention in our study.

In a study on Internet-based maintenance treatment for eating disorders following inpatient or outpatient treatment carried out in Hungary (Gulec et al., 2014), one in four participants used one-to-one-chats, while, in our study, one-to-one chats were used by about one in three women. Conclusions from direct comparisons of these data are somewhat difficult because the German and Hungarian health systems differ in terms of the availability and coverage of costs of mental health services, and fewer women (28%) received additional treatment received during the 4-month intervention period in the Hungarian study. This implies that differences in use are probably in part due to differences in the availability of other treatment options, but maybe also due to differences in sample characteristics (the sample in Hungarian study on average reported lower illness severity), and differences in the intervention design (e.g., shorter intervention period, full access to all psychoeducational content from the beginning of the intervention, weekly instead of monthly symptom monitoring, group chats instead of one-to-one chats).

Adherence in our trial was also slightly lower than in comparable trials on Internet-based self-help for bulimia nervosa: In our trial, about one in four women who had been assigned to the intervention reached the last session. In a trial on an Internet-based self-help for BN, this was the case for about one in three women (Carrard et al., 2011b). In our trial, four in ten women opened at least half of the sessions, while the same was true for nearly six out of ten women in another trial on Internet-based self-help (Sanchez-Ortiz et al., 2011a, 2011b). These differences could partly be due to the different stages of treatment the women are in and also be related to differences in the novelty of the treatment content for patients in the self-help intervention. However, this is speculative, as the authors of the above mentioned studies do not report on prior treatment experience of their sample.

The pattern of adherence observed in our study (i.e., a general decline in participation over time and a sharp decline before and after the first session) is comparable to the pattern of participation in many other Internet-based interventions for a range of *health related problems and mental disorders* (e.g., Bolier et al., 2013; Christensen et al., 2009; Christensen et al., 2002; Donker et al., 2013; Eysenbach, 2005; Linke et al., 2007; Neve et al., 2010; Norman et al., 2007; Robroek et al., 2012; Stopponi et al., 2009; van Ballegooijen et al., 2013; Wangberg et al., 2008; Wojtowicz et al., 2013).

Moreover, a decline in participation over time has not only been observed for online programs promoting health or offering self-help (e.g., Eysenbach, 2005; Linke et al., 2007; Wangberg et al., 2008), but is also typical for the *use of other websites and mobile applications*. Localytics (a company that provides a marketing and analytics platform for mobile and web apps) found that about one in four users abandon new apps after only one session and the average mobile app retention rate was as low as 20% after 90 days (Perro, 2017). Obviously, adherence to any technology-based intervention remains a challenge irrespective of the condition addressed.

### 4.2. Predictors of adherence

In our study, overall adherence to the Internet-based intervention, the use of the symptom diary, and the use of the personal goal feature were all predicted only by the number of days with excessive exercise at hospital discharge. The use of one-to-one chats was predicted by the level of education and bulimic symptoms at hospital admission, but the degree of variance explained by the model suggests that other factors that were not examined in our study must contribute to interpersonal differences in the use of one-to-one chats in an Internet-based intervention. Lastly, study dropout was only predicted by a history of a substance related disorder. The degree of explained variance in most

prediction models was comparably small, but 12.9% of the variance in the use of one-to-one chats could be explained by the analyzed moderators.

In the anorexia nervosa aftercare study with a similar study design (Fichter et al., 2012), adherence (defined dichotomous as full protocol users vs. others) was predicted by lifetime mood disorder, age of onset of eating disorder, and SIAB Inappropriate Compensatory Behaviors (which includes compensatory behavior other than vomiting, fasting, and substance abuse), with slightly larger degree of explained variance (14%) than in our study. Differences in adherence predictors could be due to the differences in adherence definition between the two studies; on the other hand, differential factors might affect adherence of different categories of eating disorder diagnoses. Finally, common factors, which have not been investigated in either of the studies, might contribute to adherence.

Findings on adherence in our study follow heterogeneous findings on adherence predictors in self-directed interventions. In one self-help intervention for bulimia nervosa, higher pretreatment symptom severity was associated with failure to take up the intervention in one study (Bara-Carril et al., 2004), while in another, symptom severity was not related to intervention uptake (Murray et al., 2003). In one study, higher EDE Eating Concern at baseline was associated with better adherence (Pretorius et al., 2009), while higher weight concerns at baseline was linked to poorer adherence in another study (Troop et al., 1996). Patients who exhibited greater dietary restraint at baseline reported better adherence in one study (Thiels et al., 1998), while in another no differences between intervention completers and non-completers were found (Steele and Wade, 2008). These inconsistencies are likely to result at least in part from inconsistent definitions and measures of adherence.

While in our study, very high or very low levels of education were associated with greater use of one-to-one chats but no other aspects of participation, in other studies, individuals with a higher education lever were more likely to participate in online health promotion programs (e.g., Brouwer et al., 2010; Spittaels and De Bourdeaudhuij, 2007; Van't Riet et al., 2010).

### 4.3. Associations between adherence and treatment outcomes

None of the measures of adherence to the Internet-based intervention was related to any of the analyzed outcomes (abstinence from binge eating and purging, frequency of binge eating episodes and of compensatory behaviors at post-intervention and follow-up). The majority of our sample had high doses of prior in- and outpatient treatment, so it is likely that the content of the Internet-based intervention and the cognitive behavioral strategies we sought to encourage patients to use were not novel to them. Poor treatment outcome after several treatment attempts is unlikely due to a lack of knowledge in patients, but rather due to motivational processes or other maintaining factors of their eating disorder. In a trial on self-help for bulimia nervosa, lower knowledge about eating disorders at baseline was related to better response (Carter et al., 2003). In our trial, all patients had prior treatment experience, and so it is implausible that they had only little knowledge about eating disorders. In analyses reported elsewhere, we have shown that the amount and kind of outpatient treatment received after hospital discharge did also not affect outcomes at post-intervention and follow-up (Beintner and Jacobi, 2018).

Contrary to our results, treatment effects were impacted by adherence in the AN relapse prevention study (Fichter et al., 2012). Post-intervention body weight was predicted by adherence to the aftercare study. This may partly be due to marked differences in the amount of additional treatment utilized by the participants. While participants in our study on average received 23 sessions of outpatient treatment during the intervention period, participants in the AN relapse prevention study on average received only 16 sessions.

Outpatient treatment was a moderator for remission in the relapse prevention program for women with bulimia nervosa (BN) based on text messaging (Bauer et al., 2012). While patients who had received additional outpatient treatment were less likely to meet DSM-IV criteria for BN both in the intervention and control group than patients who did receive additional treatment, the negative effect of no additional treatment was distinctly smaller in the intervention group.

Higher adherence has been shown to be related to more favorable intervention outcomes in a number of studies on *self-help interventions* for bulimia nervosa and binge eating disorder (Carrard et al., 2011a, 2011b; Carter et al., 2003; Ghaderi, 2006; Ghaderi and Scott, 2003; Schmidt et al., 2008; Treasure et al., 1996), while in one study, none of the adherence measures predicted abstinence from binge eating and vomiting at post treatment (Thiels et al., 2001), However, in that same study, patients who kept a food diary were even less likely to become abstinent from binge eating. In an Internet-based eating disorder *prevention program*, higher adherence predicted a greater reduction in EDI Drive for Thinness, but no other outcomes (Manwaring et al., 2008).

### 4.4. Limitations

The present study has a number of limitations: While the sample of 126 women was comparatively large and was recruited from 13 different psychosomatic hospitals in Germany, it is unlikely to be representative for women with bulimia nervosa (BN) who receive inpatient treatment in Germany. During the 5 year course of the study, > 2.500 women with BN were treated in the recruiting hospitals, while only 420 women gave consent to participate, and only 274 completed all the assessments necessary to be randomized (21 of those did not meet inclusion criteria). Assuming that all the women who received inpatient treatment were informed about the study, less than one in five were interested in participating and only one in ten reached the stage of randomization. We do not know anything about the women who declined to participate in the study, but it is possible that these women differ in terms of their readiness to use a self-directed Internet-based program, perceived need of such a program, and trust in the intervention (Crutzen et al., 2011; Jung and Berthon, 2009).

Four out of five women in our study underwent additional outpatient treatment; meaning that they received on average 23 sessions of treatment between randomization and post-intervention assessment and so the dose of outpatient treatment was substantially higher than the dose of Internet-based aftercare. However, neither adherence to the Internet-based intervention was related to any of the analyzed intervention outcomes nor was the number of outpatient treatment sessions.

The women in our sample had a comparatively high symptom load at hospital admission (they reported on average 14 binge eating episodes per week), compared with patients in other self-help or treatment trials (e.g., (Carrard et al., 2011b; Fairburn et al., 2009; Mitchell et al., 2008; Mitchell et al., 2001; Steele et al., 2011; Wilson et al., 2000); on average three to nine binge eating episodes per week). The women in our sample therefore seem to have suffered from particularly severe bulimia nervosa, and comparability of our study to trials including less severely ill patients is limited.

Another limitation of the study is the long recruitment period. During the five years it took to recruit the sample, there have been tremendous advances in information technology, and the design and functionality of the platform that was created at the beginning of the study period in 2007 may have been perceived as outdated towards the end of the recruitment period in 2012 and could have affected participation (Glasgow, 2013). Yet, patterns of change in adherence over the course of the study period were not observed. It is possible that (due to very limited resources for programming) the design of the platform was not user-friendly from the start. However, it may well be the case that the use of free-of-charge, self-directed interventions is more affected by intervention content than design. This has been suggested by other trials on Internet-based interventions, which found that intervention content (Donker et al., 2013; Geraghty et al., 2010; Webb et al., 2010),

perceived relevance to the user (Nicholas et al., 2010), peer and counselor support (W. Brouwer et al., 2011; Robinson et al., 2010; Titov et al., 2010) and periodic prompts (Fry and Neff, 2009) most critically affected adherence or dropout. Findings from a study on customer loyalty to online health care service (Gummerus et al., 2004) suggest that the usability of the intervention does not impact trust, satisfaction, or loyalty. Authors hypothesize that usability may play an important role when deciding whether to return to a site after the first visit, but not afterwards. Also, website quality seems to be more important in sites selling high touch goods (i.e., online retailers) than in e-service sites (Lynch et al., 2001).

Finally, our findings are limited by measuring adherence utilizing patients' log-on histories. While these data can be considered highly objective as such, it remains unclear how engaged patients actually were with the intervention content that required only reading once the page had been opened. We found that adherence to assignments that required a more active engagement, like diaries or surveys or one-to-one chats, was much lower. However, all of the adherence measures were highly correlated, and none of them predicted any of the analyzed outcomes.

## 5. Conclusions and implications for further research

While overall adherence to the Internet-based aftercare program for women with bulimia nervosa was lower than expected, about one in four women who had been assigned to the program became loyal users. However, adherence did not affect intervention outcomes and neither did the amount of additional outpatient treatment the women received.

Women with a very high or very low level of education were more likely to engage in one-to-one chats with a clinical psychologist, while more bulimic symptoms at hospital discharge made chats more unlikely. Adherence was not related to overall illness severity or duration at baseline. However, excessive exercise at hospital discharge seems to play some small role in adherence; engagement in excessive exercise while in inpatient treatment (with its limited opportunities to engage in other bulimic behaviors) may be a sign of insufficient motivation to change behaviors related to disordered eating.

Facing all these rather discouraging findings along with the generally disappointing outcome of women with severe and chronic bulimia nervosa, we would like to advocate further research on aftercare interventions. We suggest to apply the following lessons learned from this study for designing and evaluating future interventions: (1) The intervention content needs to be reconsidered. Women with bulimia nervosa severe enough to warrant inpatient treatment usually have had some prior treatment. They may not benefit from a higher dose of the same treatment to maintain their treatment gains. Instead of essentially repeating the principles of CBT online, the intervention could incorporate principles from motivational interviewing (Geller et al., 2001; Macdonald et al., 2012) or acceptance and commitment therapy (Juarascio et al., 2013) and focus on improving patients' quality of life (Kaplan and Strasburg, 2009). (2) The usability of the program platform could be improved. Some patients gave us feedback that the platform was somewhat cumbersome to navigate. The program could be made more appealing by transforming reading assignments into short video lectures, which is typical in modern online learning platforms. In addition, instant automated feedback to surveys, customization of the program content and possibly gamification (e.g., Cafazzo et al., 2012; Fleming et al., 2016) of some program features could improve user satisfaction (Gummerus et al., 2004). (3) Principles of user-centered design should be applied more carefully in the development of new interventions. This includes thoroughly assessing patients' needs and expectations and actively involving patients in program development.

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